NASA Earth System Science and the IPCC AR5

Chris Field
Department of Global Ecology
Carnegie Institution

24 June 2009

IPCC: A brief history

- Bert Bolin, 1988
- Intergovernmental program under UN system
  - Official parents WMO and UNEP
  - Governments are the members of the IPCC
  - Unique buy-in
- Full assessments: 1990, 1995, 2001, 2007
- Special reports: 1994 (2), 1997 (2), 2000 (3), 2005 (2)
- Shared Nobel Peace Prize: 2007

- Input from hundreds of leading scientists
- Comprehensive assessment
- Multi-stage, monitored review
- Word-by-word SPM approval

- WG1: Science of Climate Change
- WG2: Impacts, Adaptation, and Vulnerability
- WG3: Mitigation
- Task Group on Inventories
- Task Group on Data and Scenario Support for Impacts and Climate Analysis

Chairman

Rajendra K. Pachauri

IPCC Vice - Chairs

Ogunlade Davidson
(Sierra Leone)

Jean-Pascal van Ypersele
(Belgium)

Hoesung Lee
(Republic of Korea)

Working Group I
The physical science basis

Co-chairs

Thomas Stocker
(Switzerland)

Dahe Qin
(China)

Working Group II
Impacts, adaptation, vulnerability

Co-chairs

Christopher Field
(USA)

Vicente Barros
(Argentina)

Working Group III
Mitigation

Co-chairs

Ottmar Edenhofer
(Germany)

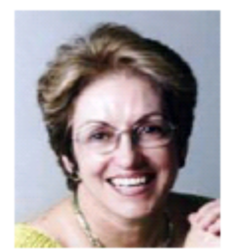
Ramon Pichs-Madruga
(Cuba)

Youba Sokona
(Mali)

Task Force Bureau
National Greenhouse Gas Inventories

Co-chairs

Taka Hiraishi
(Japan)



Thelma Krug
(Brazil)

IPCC AR5

- Preserve basic WG structure
- Preserve basic 6-year schedule, but with 6-9 mo between WG 1 and 2-3.
  - WG1 target 2013
- Scoping meeting – July, 2009; Venice
- SR Extremes -- 2011

IPCC AR5

- Move from "it's real" to "here is the information you need to make good decisions for your stakeholders"
- Risk management framework
- Build on full range of available information
- Underlying mechanisms
- Adaptation
- Coordination among WGs

Keys to a successful assessment

- Salience
- Credibility
- Legitimacy

Cash et al. PNAS 2003

Remote sensing in the AR4

- Occurrences of "satellite" or "remote sensing"
  - WG1: 410
  - WG2: 30
  - WG3: 20

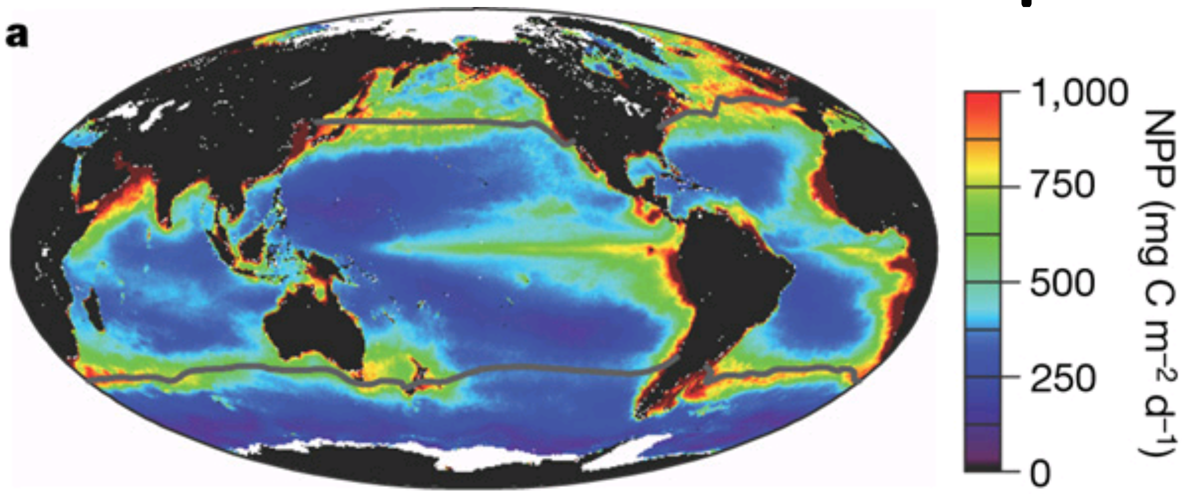
Remote sensing in WG2

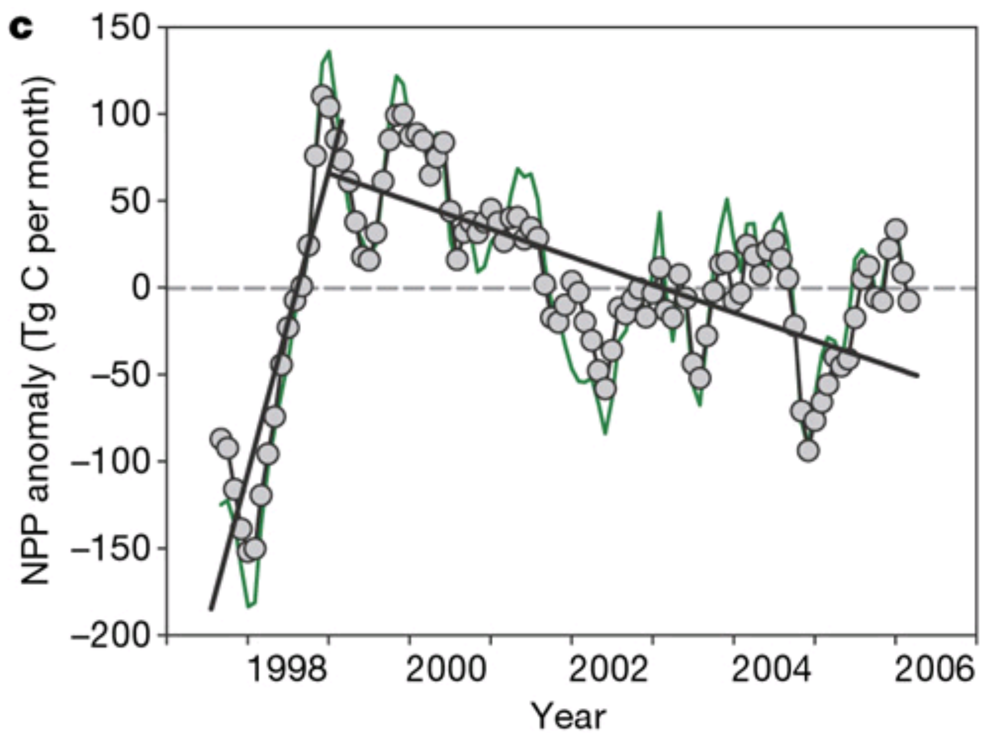
• Observed changes:	8
• New assessment methods:	1
• Freshwater:	0
• Ecosystems:	8
• Agriculture and forestry:	0
• Coasts:	1
• Polar regions:	8
• Industry, Settlements, Society:	0
• Health:	0
• Adaptation:	0
• Sustainability:	0

Why so little?

- Hazy definition of border between climate science and impacts
- RS products not at the level of stakeholder interest
- Short time series
- Natural processes bias
- Rough interface between RS and projections

Ocean impacts

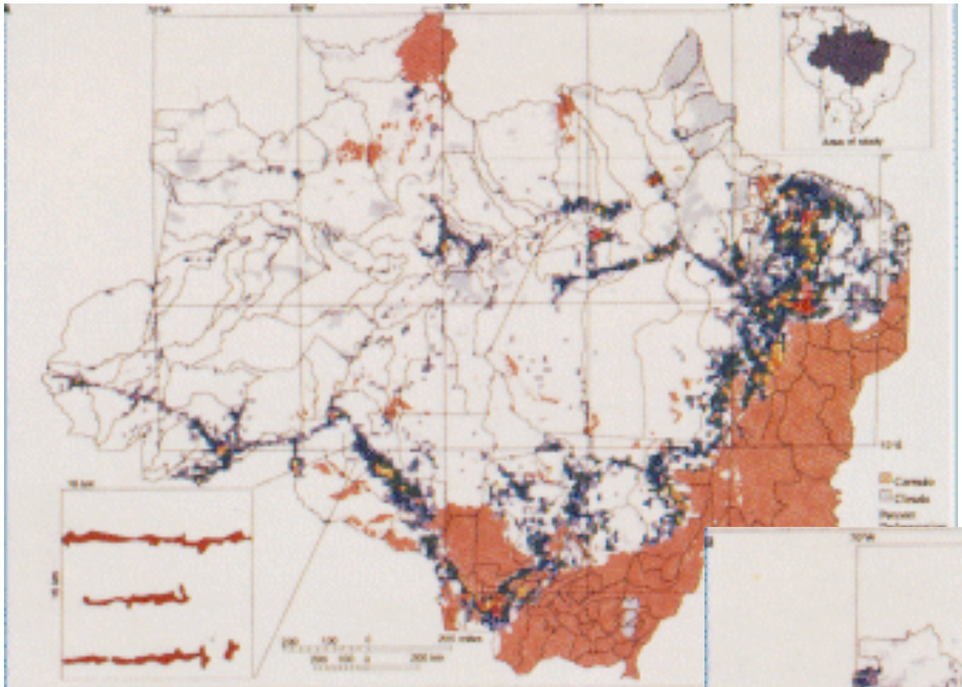




- Oceans
  - half of global NPP
  - 70% of surface area
  - 41% has multiple impacts

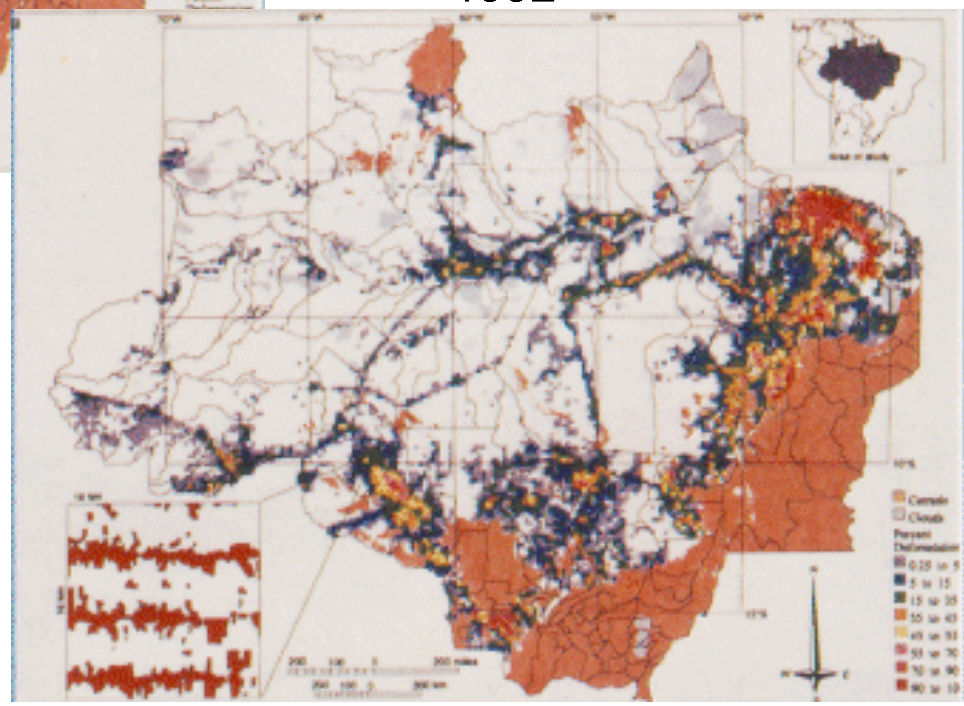
Behrenfeld et al Nature 2006

Large area deforestation: The pioneer era



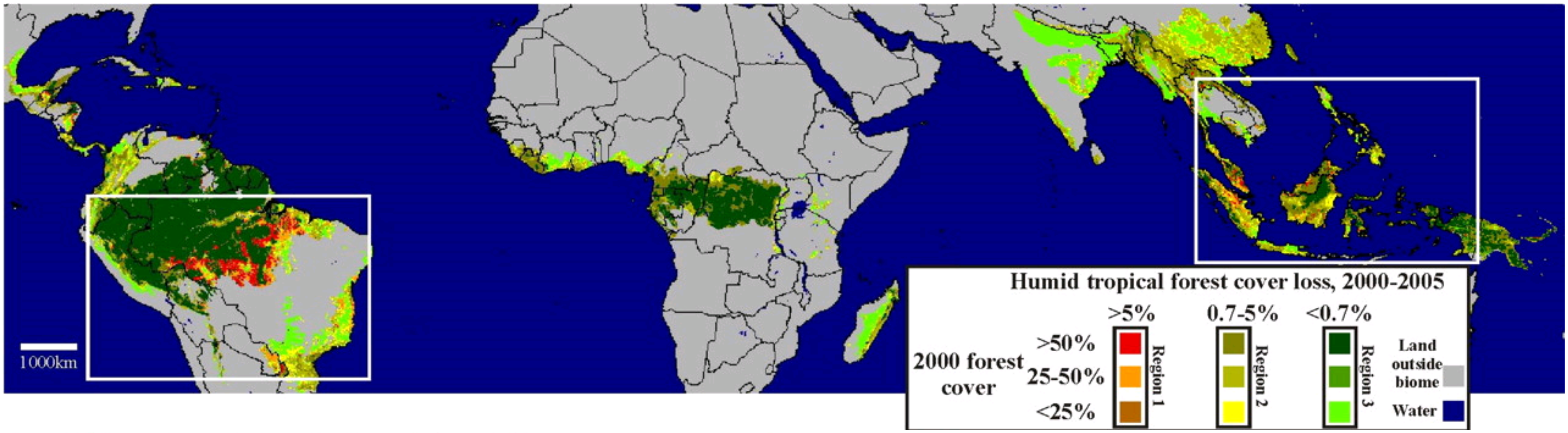
1984

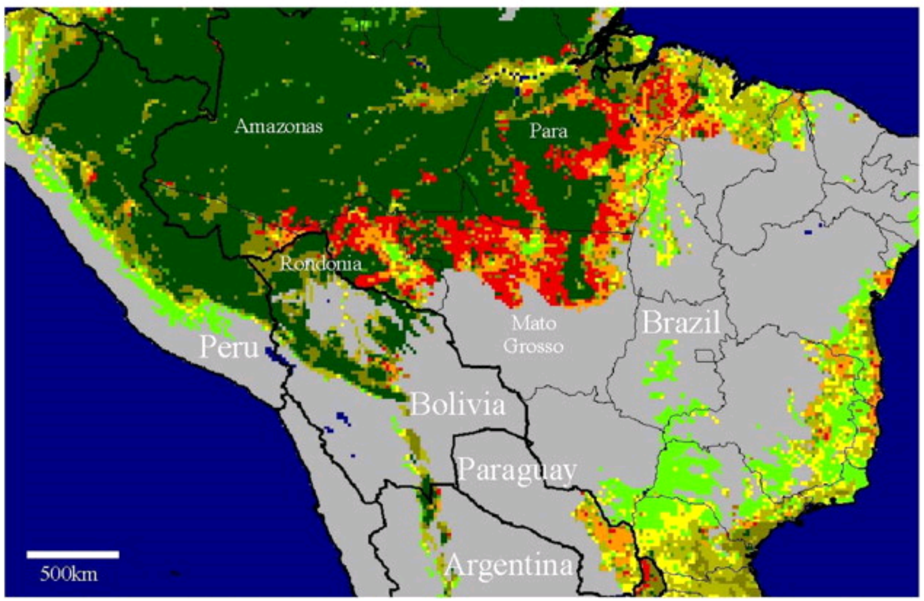
1992

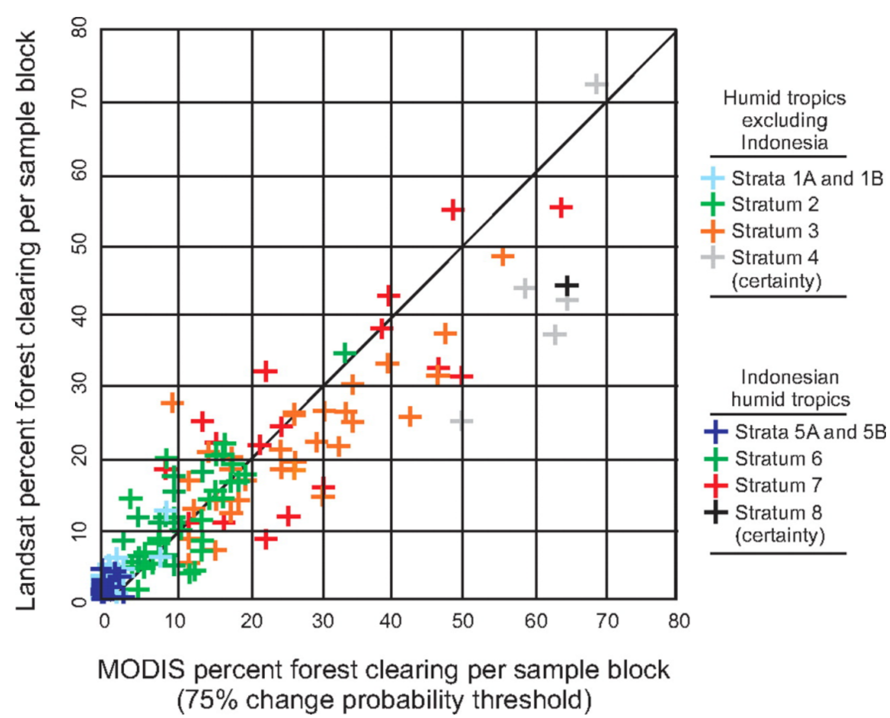


Skole & Tucker Science1993

Global analysis of tropical deforestation: 2000-2005





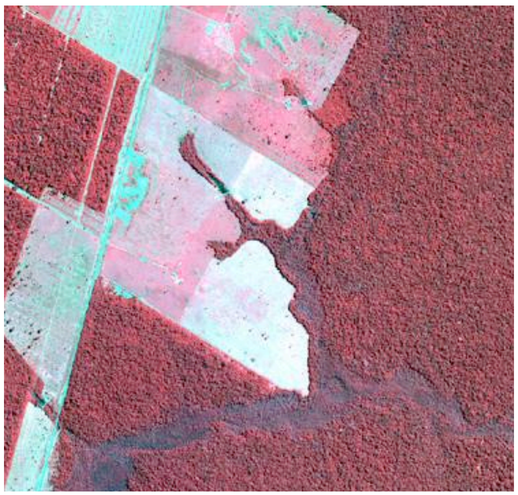


MODIS with LANDSAT calibration:

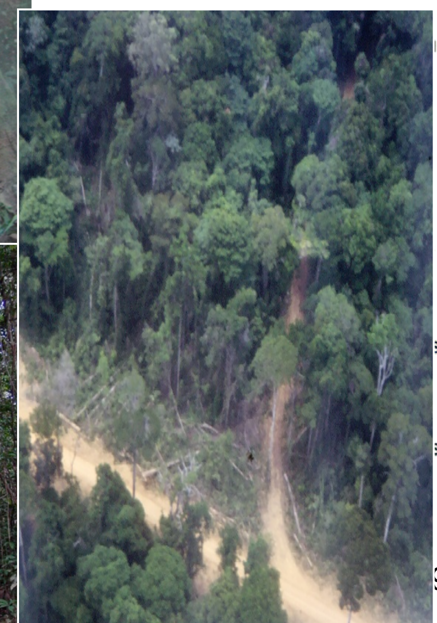
Hansen et al. PNAS 2008

Cryptic Deforestation

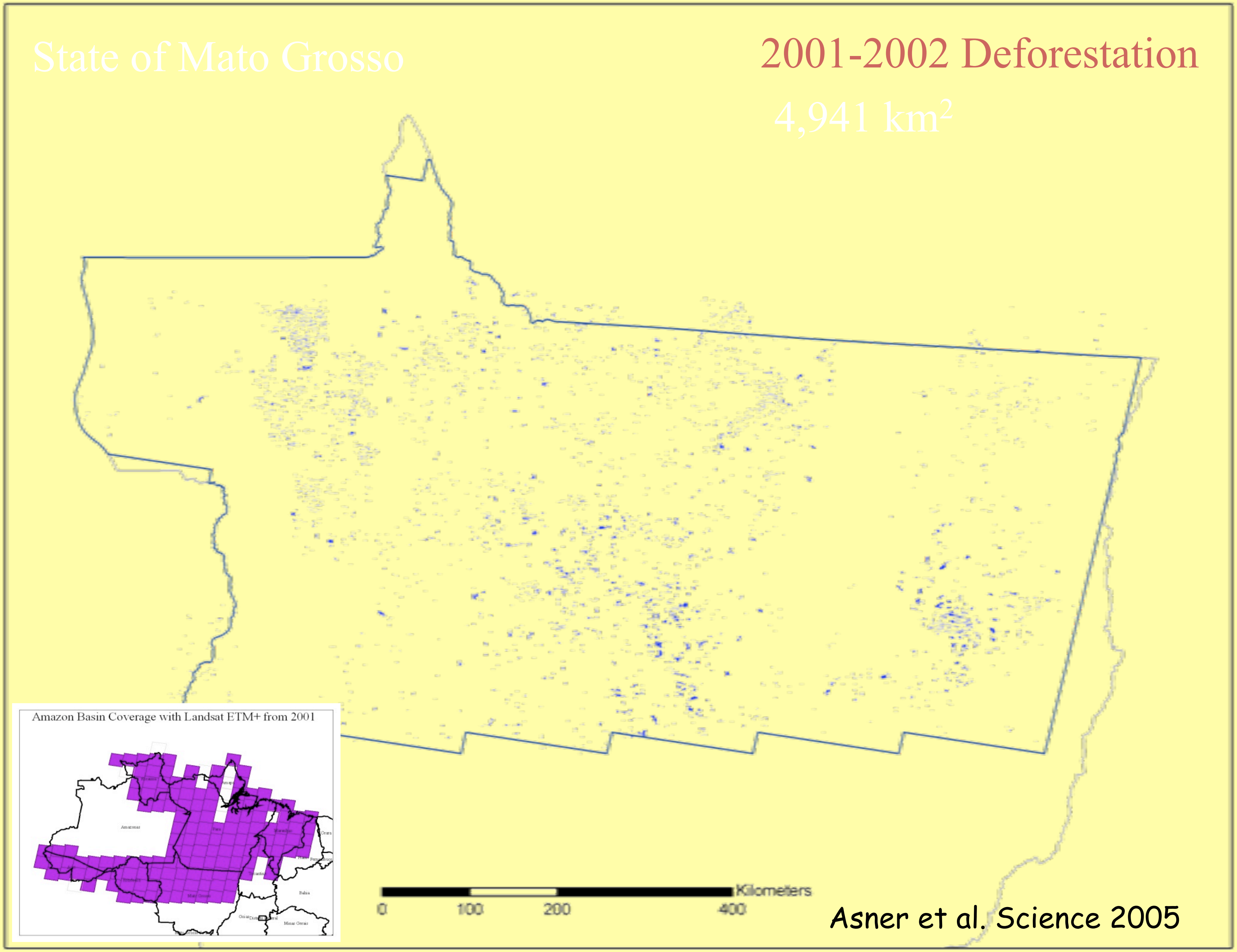
Selective logging or timber harvesting has become a major form of land use in the Amazon

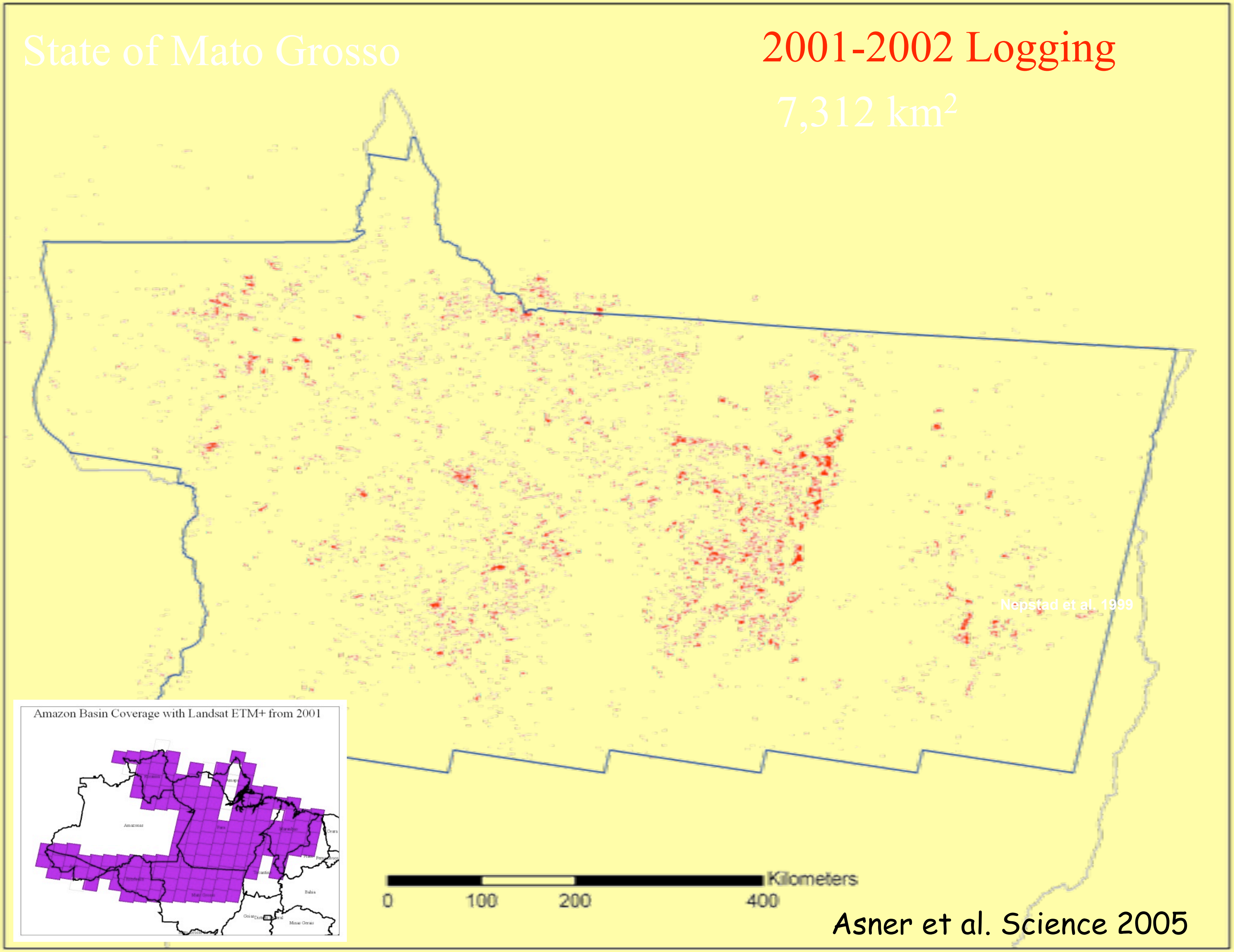


Readily observed from space

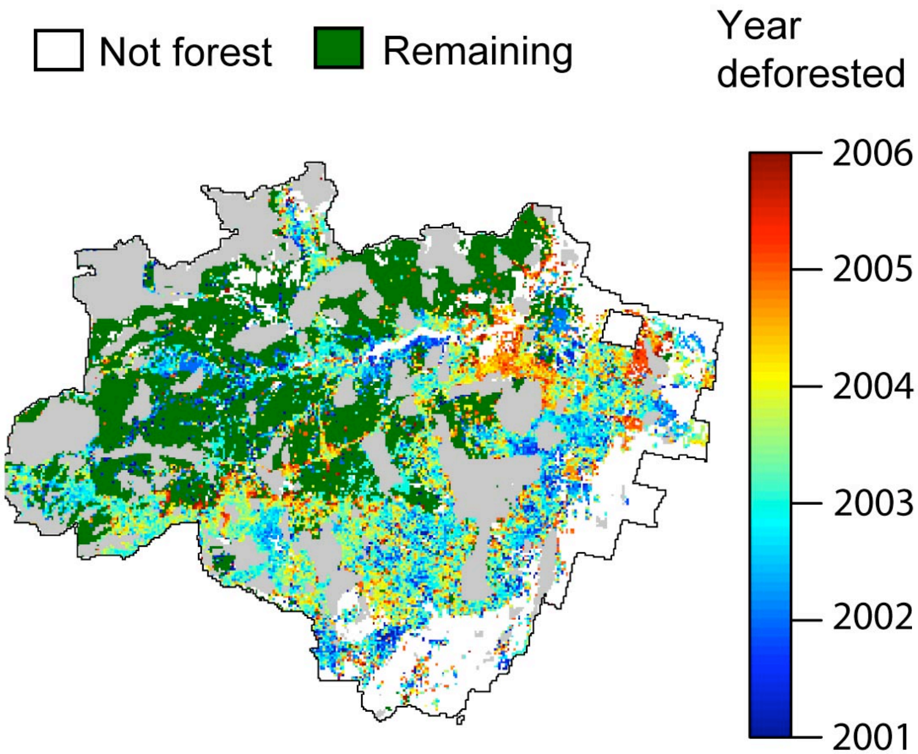


Much more challenging to observe

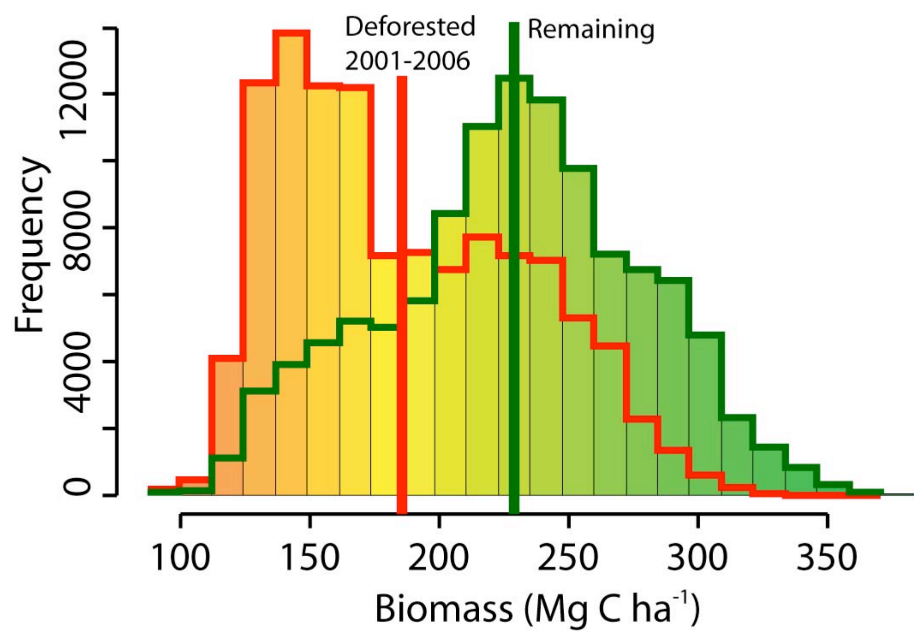

State of Mato Grosso
2001-2002 Deforestation
4,941 km^2
Amazon Basin Coverage with Landsat ETM+ from 2001
Kilometers
0
100
200
400
Asner et al. Science 2005


State of Mato Grosso
2001-2002 Logging
7,312 km²
Nepstad et al. 1999
Amazon Basin Coverage with Landsat ETM+ from 2001
Kilometers
0
100
200
400
Asner et al. Science 2005

Biomass loss in deforestation

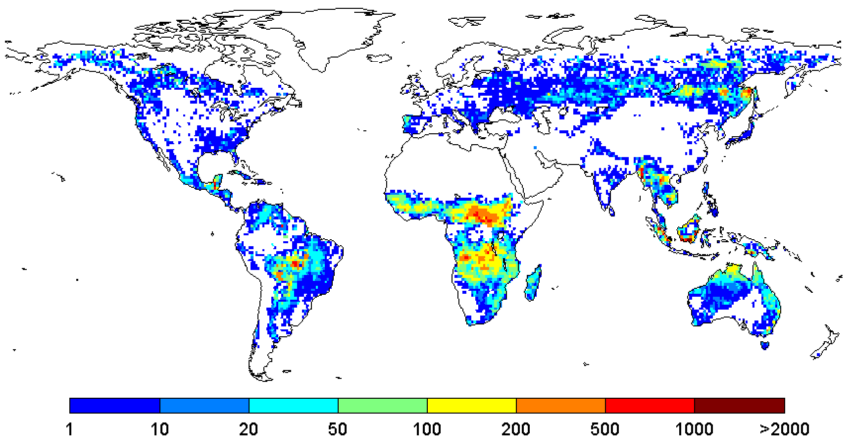


Remaining Amazon forests have greater biomass than those already deforested.



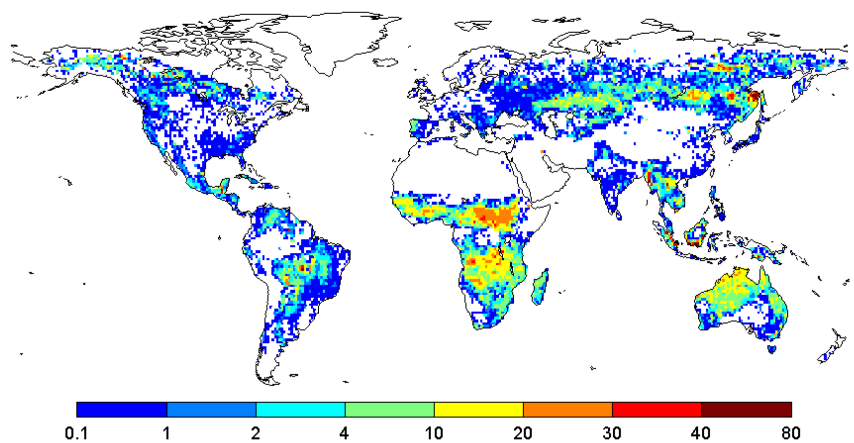
Loarie et al. GRL 2009 (in press)

Global wildfire and carbon emissions from wildfire



1997 – 2004 mean annual fire emissions (g C m^{-2} y^{-1})

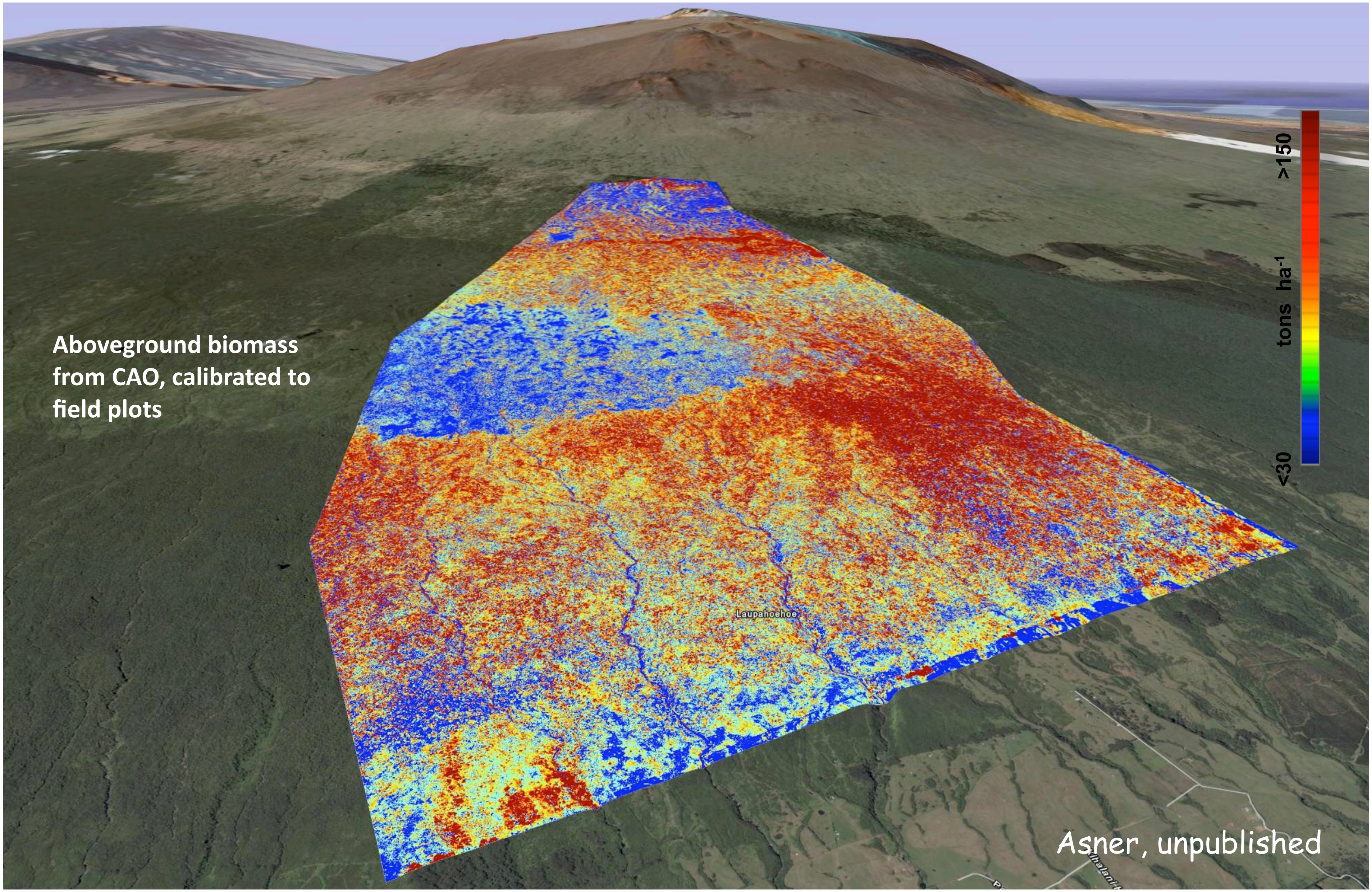
Fire counts from MODIS, VIRS, and ATSR



% C losses from fire emissions during 1997-2004

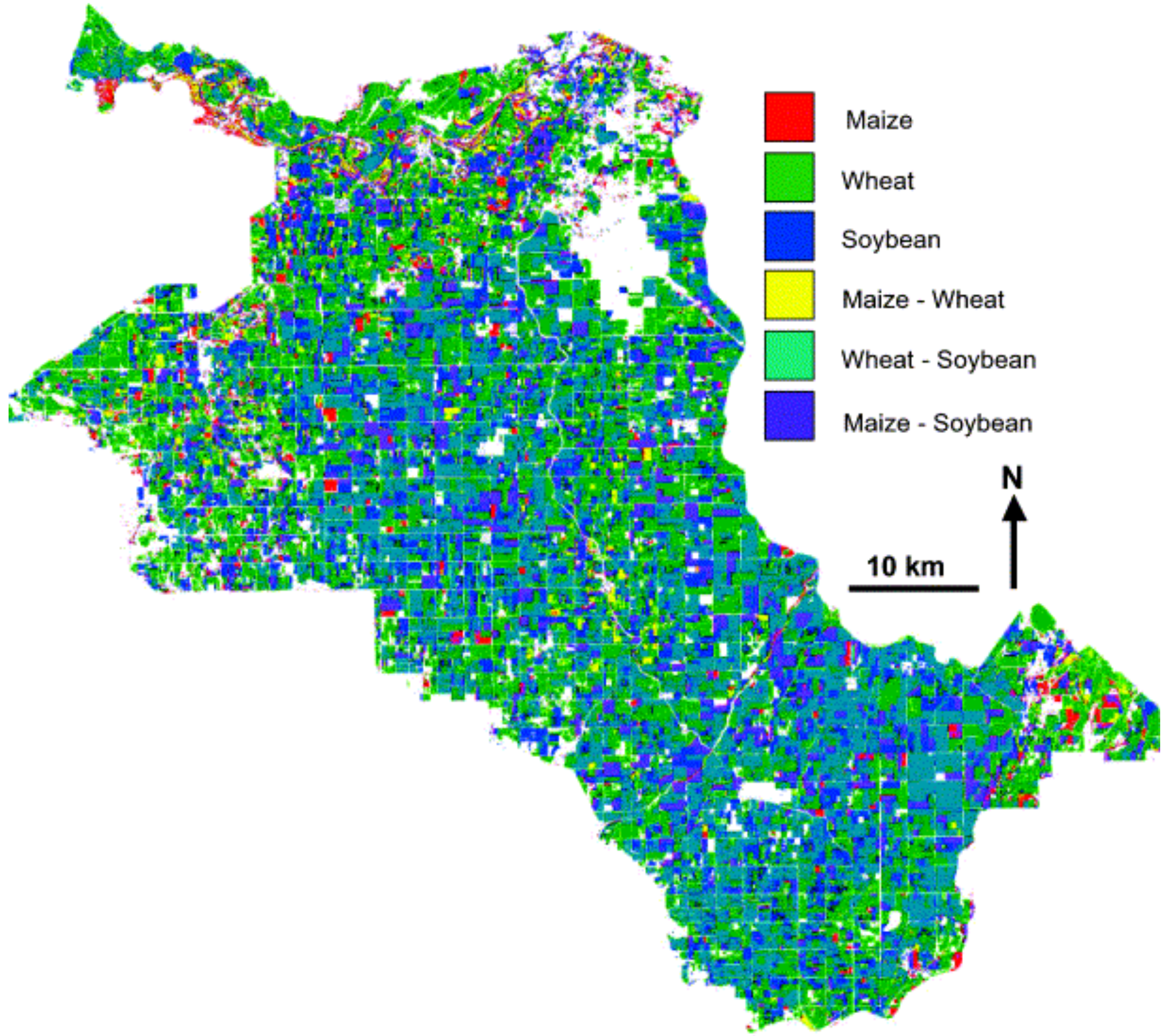
Van der Werf et al. Atmos. Chem. Phys 2006

Fine-scale biomass from aircraft data



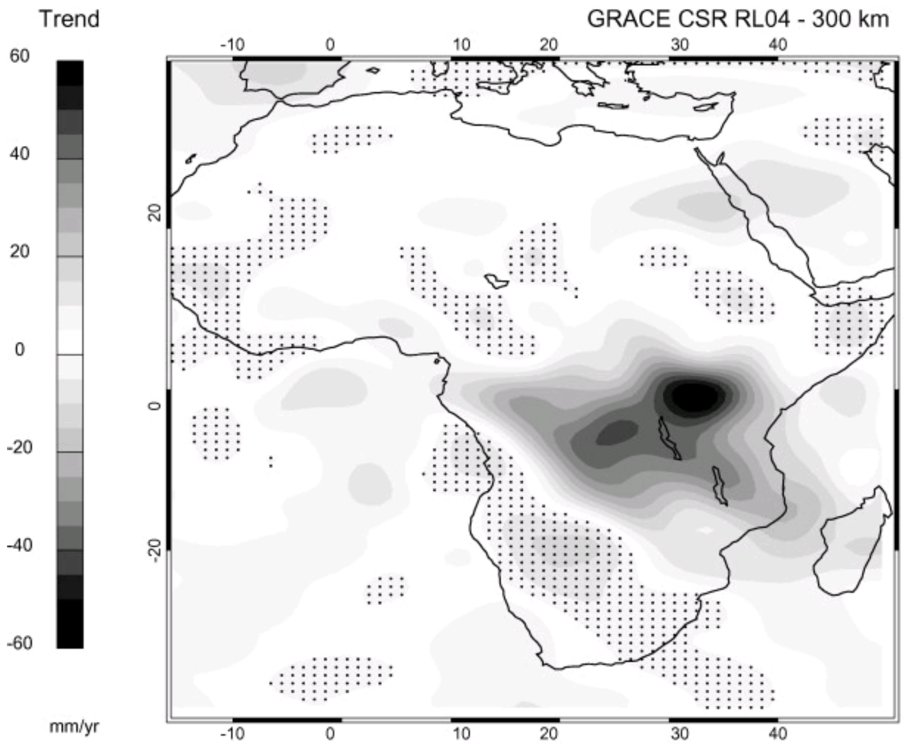
Variability in ag yields

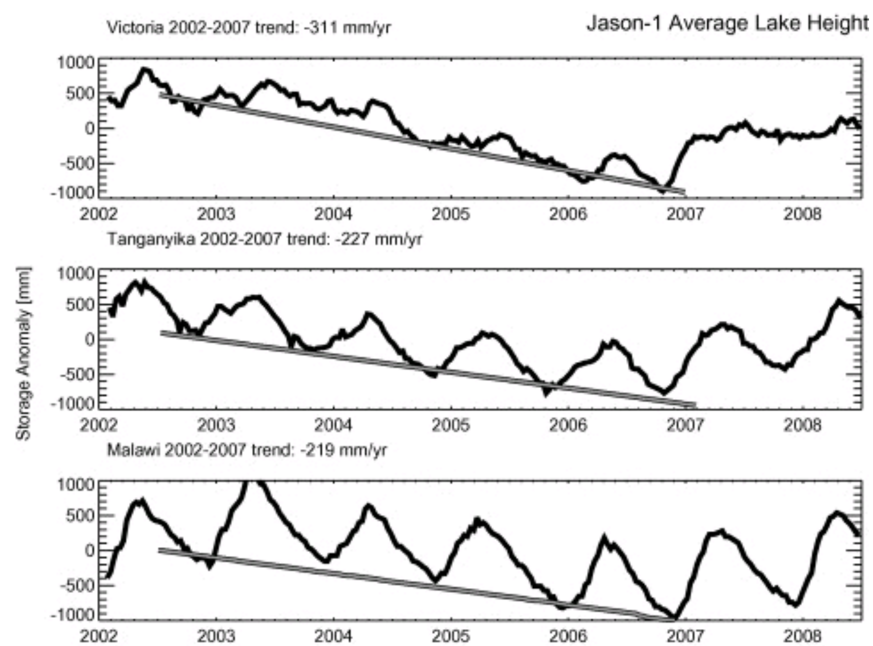
Crop ID and yield estimated from multi-temporal LANDSAT NDVI



Lobell et al. *Ag. Ecosys. Environ.* 2003

Continental scale water balance

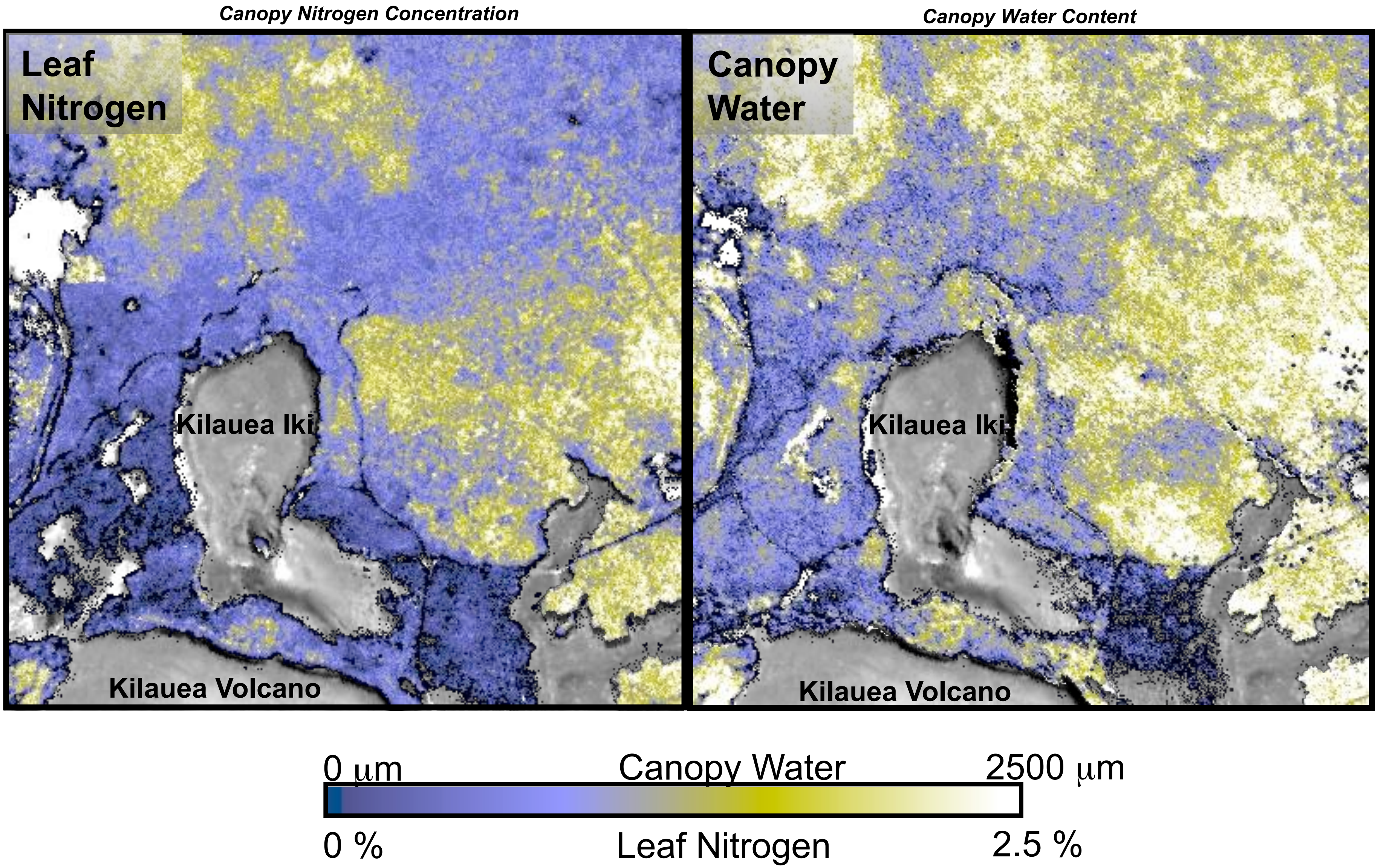




Lake level from JASON-1
Regional soil moisture from GRACE

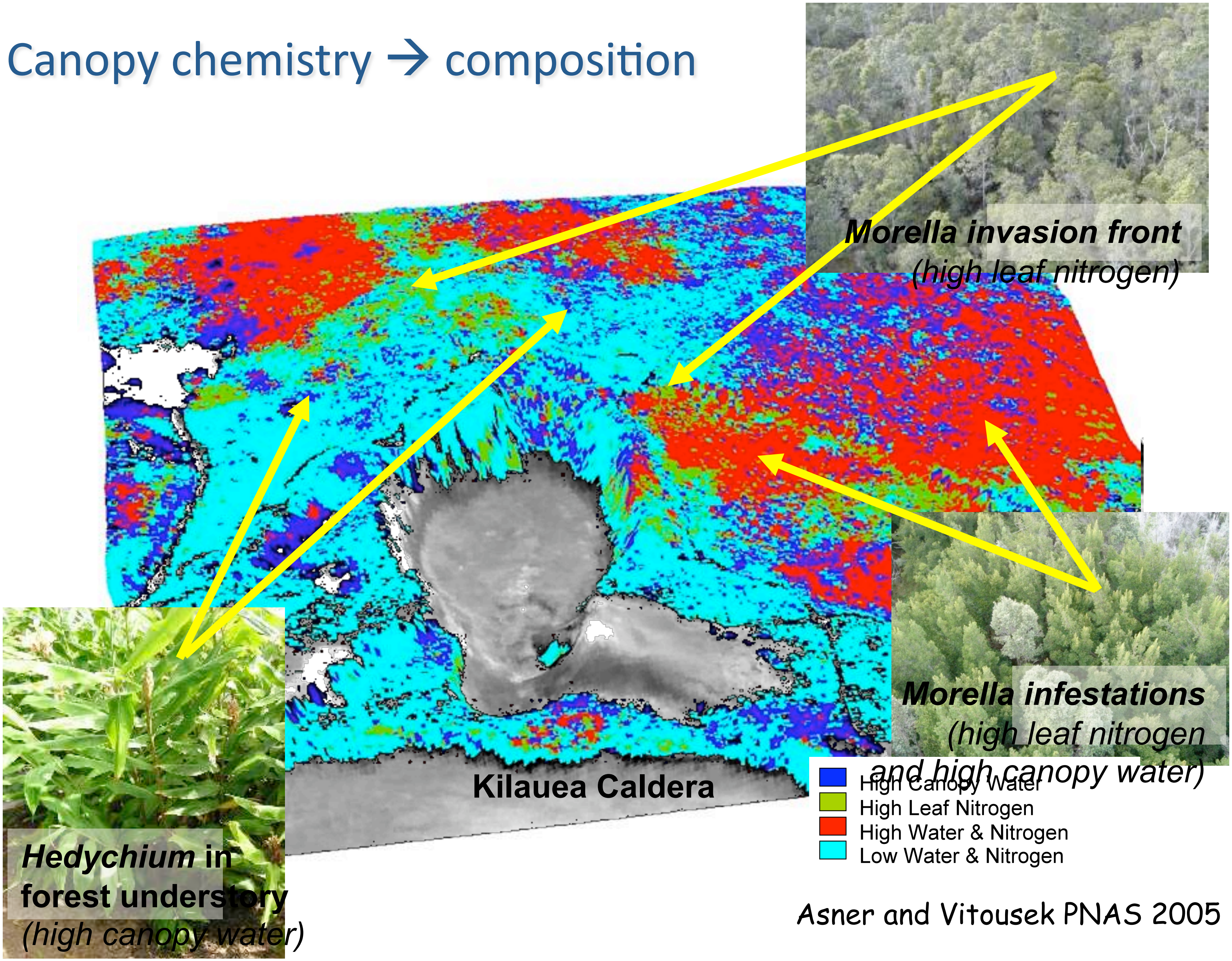
Swenson & Wahr, J Hydrology 2009

Biological invasions from aircraft data



Asner and Vitousek PNAS 2005

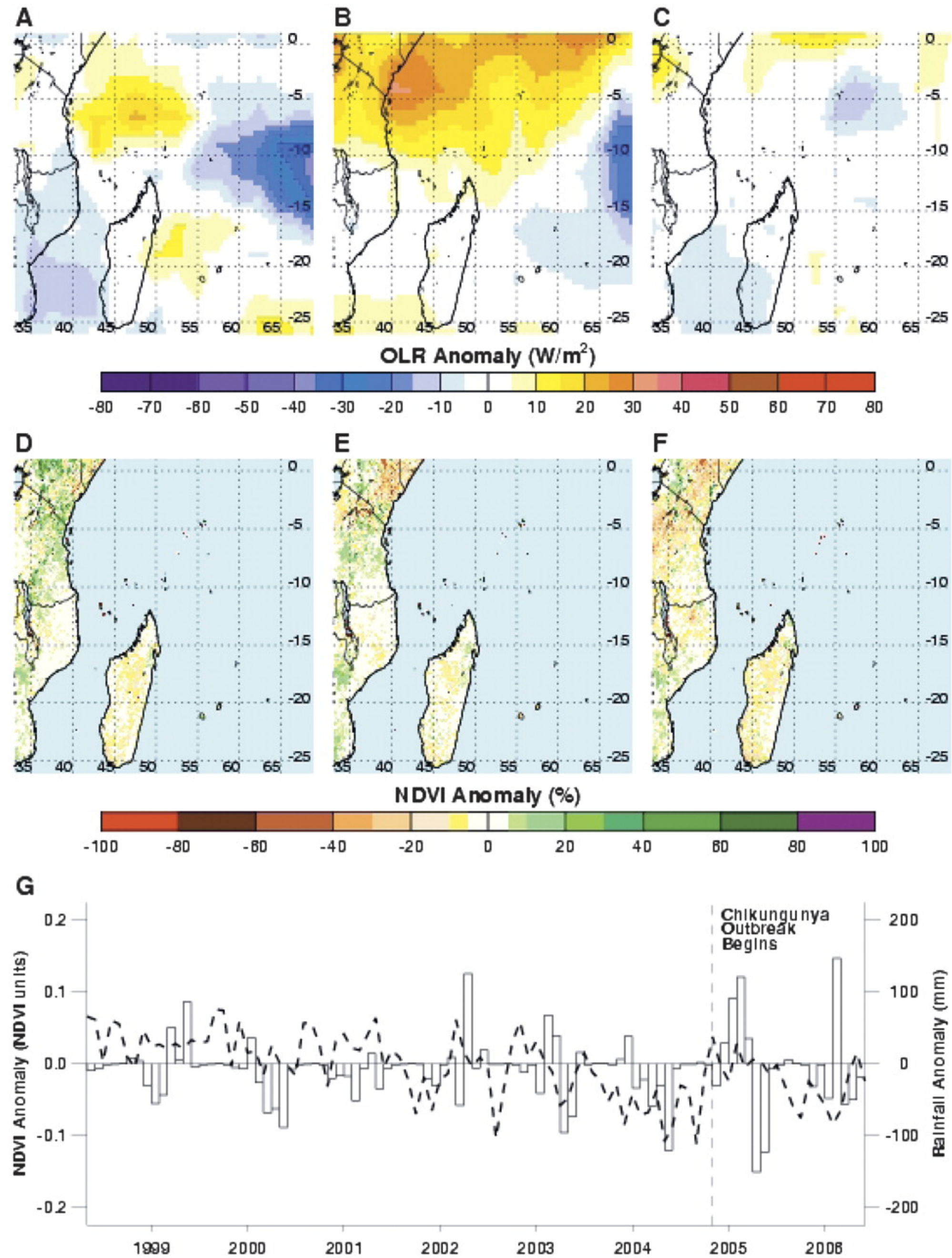
Canopy chemistry → composition



Asner and Vitousek PNAS 2005

Chikungunya outbreaks in East Africa

Outbreaks associated with warm, dry conditions, based on SPOT-4 and OLR from NOAA polar orbiter.



Chretien et al. Am J Trop Med Hyg 2007

Energy and Infrastructure

Elvidge et al. GCB 1997

Other areas

- Ocean acidification
- Flood risk
- Glacial lake outburst
- Permafrost
- Infrastructure at risk
- Coastal hazards
- Crop growth potential
- Animal populations
- Crop and forest pests and diseases
- Effectiveness of adaptations
- Effectiveness of mitigations

Priority areas for new science

- Integration of models and observations
  - Coordinated intercomparisons, and evaluations against data
  - Data assimilation
- Obtaining maximum value from observations
  - Extending satellite studies to a broader range of topics of stakeholder concern
  - Expanding the suite of time-series studies
  - Enhanced detection/attribution analysis
  - Novel sources: traditional knowledge, citizen science
- Formal analysis of adaptation options
  - Toward common frameworks
- Oceans
- Risk, Risk, Risk